

In all mains-operated equipment certain important safety requirements must be met. The relevant standard for most sound equipment is Safety of Information Technology Equipment, including Electrical Business Equipment (European Harmonized British Standard BS EN 60950:1992). Electrical safety under this standard relates to protection from

- a hazardous voltage, that is, a voltage greater than 42.4 V peak or 60 V d.c.;
- a hazardous energy level, which is defined as a stored energy level of 20 Joules or more or an available continuous power level of 240 VA or more at a potential of 2 V or more;
- a single insulation fault which would cause a conductive part to become hazardous;
- the source of a hazardous voltage or energy level from primary power;
- secondary power (derived from internal circuitry which is supplied and isolated from any power source, including d.c.)

Protection against electric shock is achieved by two classes of equipment.

Class I equipment uses basic insulation; its conductive parts, which may become hazardous if this insulation fails, must be connected to the supply protective earth.

Class II equipment uses double or reinforced insulation for use where there is no provision for supply protective earth (rare in electronics – mainly applicable to power tools).

The use of a Class II insulated transformer is preferred, but note that when this is fitted in a Class I equipment, this does not, by itself, confer Class II status on the equipment.

Electrically conductive enclosures that are used to isolate and protect a hazardous supply voltage or energy level from user access must be protectively earthed regardless of whether the mains transformer is Class I or Class II.

Always keep the distance between mains-carrying parts and other parts as large as possible, but never less than required.

If at all possible, use an approved mains entry with integrated fuse holder and on/off switch. If this is not available, use a strain relief (Figure, note 2) on the mains cable at the point of entry. In this case, the mains fuse should be placed after the double-pole on/off switch unless it is a Touchproof® type or similar. Close to each and every fuse must be affixed a label stating the fuse rating and type.

The separate on/off switch (Figure, note 4), which is really a 'disconnect device', should be an approved double-pole type (to switch the phase and neutral conductors of a single-phase mains supply). In case of a three-phase supply, all phases and neutral (where used) must be switched simultaneously. A pluggable mains cable may be considered as a disconnect device. In an approved switch, the contact gap in the

off position is not smaller than 3 mm.

The on/off switch must be fitted by as short a cable as possible to the mains entry point. All components in the primary transformer circuit, including a separate mains fuse and separate mains filtering components, must be placed in the switched section of the primary circuit. Placing them before the on/off switch will leave them at a hazardous voltage level when the equipment is switched off.

If the equipment uses an open-construction power supply which is not separately protected by an earthed metal screen or insulated enclosure or otherwise guarded, all the conductive parts of the enclosure must be protectively earthed using green/yellow wire (green with a narrow yellow stripe – do not use yellow wire with a green stripe). The earth wire must not be daisy-chained from one part of the enclosure to another. Each conductive part must be protectively earthed by direct and separate wiring to the primary earth point which should be as close as possible to the mains connector or mains cable entry. This ensures that removal of the protective earth from a conductive part does not also remove the protective earth from other conductive parts.

Pay particular attention to the metal spindles of switches and potentiometers: if touchable, these must be protectively earthed. Note, however, that such components fitted with metal spindles and/or levers constructed to the relevant British Standard fully meet all insulation requirements.

The temperature of touchable parts must not be so high as to cause injury or to create a fire risk.

Most risks can be eliminated by the use of correct fuses, a sufficiently firm construction, correct choice and use of insulating materials and adequate cooling through heat sinks and by extractor fans.

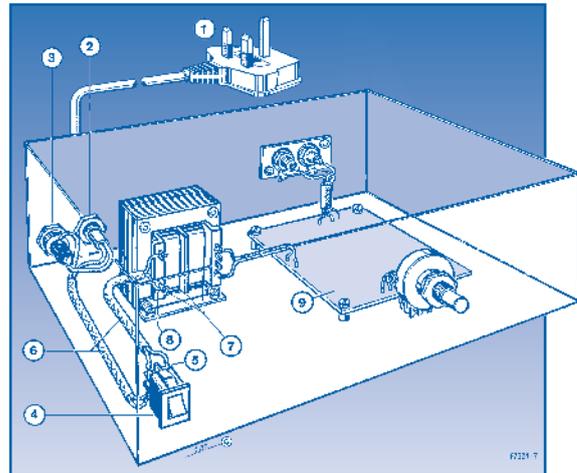
The equipment must be sturdy: repeatedly dropping it on to a hard surface from a height of 50 mm must not cause damage. Greater impacts must not loosen the mains transformer, electrolytic capacitors and other important components.

Do not use dubious or flammable materials that emit poisonous gases.

Shorten screws that come too close to other components.

Keep mains-carrying parts and wires well away from ventilation holes, so that an intruding screwdriver or inward falling metal object cannot touch such parts.

As soon as you open an equipment, there are many potential dangers. Most of these can be eliminated by disconnecting the equipment from the mains before the unit is opened. But, since testing requires that it is plugged in again, it is good practice (and safe) to fit a residual current device (RCD)\*, rated at not more than 30 mA to the mains system (sometimes it is possible



1. Use a mains cable with moulded-on plug.
2. Use a strain relief on the mains cable.
3. Affix a label at the outside of the enclosure near the mains entry stating the equipment type, the mains voltage or voltage range, the frequency or frequency range, and the current drain or current drain range.
4. Use an approved double-pole on/off switch, which is effectively the 'disconnect device'.
5. Push wires through eyelets before soldering them in place.
6. Use insulating sleeves for extra protection.
7. The distance between transformer terminals and core and other parts must be  $\geq 6$  mm.
8. Use the correct type, size and current-carrying capacity of cables and wires – see shaded table below.
9. A printed-circuit board like all other parts should be well secured. All joints and connections should be well made and soldered neatly so that they are mechanically and electrically sound. Never solder mains-carrying wires directly to the board: use solder tags. The use of crimp-on tags is also good practice.
10. Even when a Class II transformer is used, it remains the on/off switch whose function it is to isolate a hazardous voltage (i.e., mains input) from the primary circuit in the equipment. The primary-to-secondary isolation of the transformer does not and can not perform this function.

to fit this inside the mains outlet box or multiple socket).

\* Sometimes called residual current breaker – RCB – or residual circuit current breaker – RCCB.

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**3-core mains cable to BS6500 1990 with three stranded conductors in thick PVC sheath**

|                           |                           |                            |                            |
|---------------------------|---------------------------|----------------------------|----------------------------|
| <b>Max current</b>        | <b>3 A</b>                | <b>6 A</b>                 | <b>13 A</b>                |
| <b>conductor size</b>     | <b>16/0.2 mm</b>          | <b>24/0.2 mm</b>           | <b>40/0.2 mm</b>           |
| <b>Nom cond area</b>      | <b>0.5 mm<sup>2</sup></b> | <b>0.75 mm<sup>2</sup></b> | <b>1.25 mm<sup>2</sup></b> |
| <b>overall cable dia.</b> | <b>5.6 mm</b>             | <b>6.9 mm</b>              | <b>7.5 mm</b>              |

**Insulated hook-up wire to DEF61-12**

|                             |                            |                           |                            |
|-----------------------------|----------------------------|---------------------------|----------------------------|
| <b>Max current</b>          | <b>1.4 A</b>               | <b>3 A</b>                | <b>6 A</b>                 |
| <b>Max working voltage</b>  | <b>1000 V rms</b>          | <b>1000 V rms</b>         | <b>1000 V rms</b>          |
| <b>PVC sheath thickness</b> | <b>0.3 mm</b>              | <b>0.3 mm</b>             | <b>0.45 mm</b>             |
| <b>conductor size</b>       | <b>7/0.2 mm</b>            | <b>16/0.2 mm</b>          | <b>24/0.2 mm</b>           |
| <b>Nom cond area</b>        | <b>0.22 mm<sup>2</sup></b> | <b>0.5 mm<sup>2</sup></b> | <b>0.95 mm<sup>2</sup></b> |
| <b>overall wire dia</b>     | <b>1.2 mm</b>              | <b>1.6 mm</b>             | <b>2.05 mm</b>             |

**3-flat-pin mains plug to BS 1363A**